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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN CARRIAGES FOR AUTOMATIC RAIL-LESS TRANSPORTATION SYSTEMS

(71) We, BURO PATENT AG, a corporation registered under the laws of Switzerland, of Spielhof 3, 8750 Glarus, Switzerland, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a carriage for an automatic rail-less transportation system incorporating a track of a kind whose presence can be automatically sensed by sensing means on the carriage, which is to travel along the track, so that the carriage is steered along the track under the control of signals from its track sensing means.

Such a transportation system is for example known from Swiss Patent Specification No. 475,895, wherein a carriage is automatically steered along a track in the form of a guide strip. Such a guide strip, for example of iron, is located at the base of the track over which the carriage is to travel. This guide strip is for example inductively sensed by a pair of sensing heads on the carriage which, via a control device, actuate the steering motor of a steering device which operates a pair of steerable wheels. A pair of traction wheels are driven by a separate motor. This type of control requires, however, a costly control and steering device.

The primary object of the present invention is to provide a carriage for an automatic rail-less transportation system which carriage is of comparatively simple and operationally reliable construction and which with the exception of the drive for the traction wheels, incorporates no additional steering device.

Thus according to the invention there is provided a carriage including two laterally spaced traction wheels and track sensing means adapted to sense a track without contacting the same, for use in an automatic transportation system including a track sensable by said sensing means, said sensing means comprising a central sensing device situated substantially on the longitudinal centre-line of the carriage, and two lateral sensing devices situated one on each side of said centre-line, said central sensing device being operative, upon sensing said track in use, to cause the said traction wheels to rotate at the same speed and each of the said lateral sensing devices being operative, upon sensing the track in use, to cause the said traction wheels to rotate at mutually different speeds, in such manner as to steer the carriage along the track.

Such an arrangement permits a particularly simple design of the carriage because the traction wheels which are in any case necessary for driving the carriage are also used for steering the carriage. The steerable wheels with a steering device and additional steering motor necessary in the known transportation systems mentioned above become completely superflous with the carriage of the present invention. In addition to the already indicated simple and therefore cheap construction of the carriage the further particular advantage is obtained that the present carriage is much more manoeuverable than the carriage of such known transportation systems, because the carriage can make practically right-angled turns which is not possible in the known transportation systems. The carriage can also travel both forwards and backwards and is equally manoeuverable in both directions. This is particularly important if the transportation system is to be used in a building having narrow passageways which generally run at right angles to one another and do not permit wide turns.

The invention also provides an automatic transportation system comprising at least one carriage as set forth above, and a track sensable by the sensing means of the or each

said carriage.

A particularly preferred embodiment of the transportation system incorporating the invention results from the incorporation of a destination control system according to Patent Specification No. 1190211.

Some exemplary embodiments of automatic rail-less transportation systems incorporating the invention will now be described with reference to the accompanying drawings, wherein:—

Fig. 1 is a perspective view of a carriage;

Fig. 2 is a somewhat diagrammatic bottom view of the carriage shown in Fig. 1;

Fig. 3 is a somewhat diagrammatic bottom view of a modified carriage;

Fig. 4 is a fragmentary cross-sectional view taken on the line IV-IV of Fig. 3;

Fig. 5 shows part of a branched track portion in detail;

Fig. 6 is a circuit diagram of the control means, sensing means and the traction wheel drive means of the carriage of Fig. 2;

Fig. 7 shows a modification of the lower portion of the circuit diagram of Fig. 6, adapted for use in a carriage according to Figs. 3 and 4;

Fig. 8 is a more detailed circuit diagram of a sensing device for the system of Fig. 6; and

Fig. 9 is a circuit diagram similar to Fig. 8, for a different sensing device.

Fig. 1 shows a carriage 1 with a chassis 2 supporting a loading platform 3 for goods to be transported. A removable cover 4, here shown to be transparent, overlies the platform 3 to form a receptacle for the goods. As more fully described hereinafter with reference to Fig. 2, carriage 1 has a pair of swivelable rear wheels *5a*, *5b* and a pair of non-swivelable traction wheels *6a* and *6b*, only the left-hand wheel *5b*, *6b* of each pair being visible in Fig. 1. The vehicle is steered by the selective driving of one or both of its two traction wheels, also described in detail hereinbelow. A panel 7 aboard the vehicle carries switches for setting a reading means to a destination code which reacts in a particular manner to code markings which the vehicle is to encounter at various points along its track. This track is defined by a continuous guide strip 17 which differs from the floor 23. The guide strip 17 can be a colour strip but is preferably a metal strip optionally of ferromagnetic material. For sensing the guide strip is used a sensing means 21 (Fig. 2) having sensing devices in the form of a central sensing head 22, a right-hand sensing head 23 and a left-hand sensing head 24. Whilst the right and left sensing heads 23, 24 each have a single sensor *23a*, *24a*, the central sensing head 22 has two sensors *22a*, *22b*, arranged at a distance from one another. The sensors project downwardly from the underside of the vehicle.

The sensing element 11 of a rapid stopping device projects forwardly and is formed from a fluid-filled tube whose deformation upon contact with an obstacle actuates one or both of two pressure switches *12a*, *12b* to de-activate the wheel drive, as more fully explained in the subsequent description of Fig. 6. Instead of the tube sensing element 11 it is also possible to use other sensing devices such as mechanical sensing elements or those of the the echo type, to sense the path for obstacles.

In Fig. 2 is shown a pair of separate drive motors *20a*, *20b* coupled with the shafts of traction wheels *6a* and *6b* by speed-reducing transmissions here shown as worm drives *25a*, *25b*. Also disposed on the underside of the vehicle 1 are a set of reading elements 30, 31, 32, 33, 34, 35 in the form of magnetic switches. These magnetic switches react to corresponding magnetic marking elements of code markings arranged at V-junctions. The junction of the code markings is described hereinafter with reference to Fig. 5. Reading element switches 32, 33 are assumed to have been rendered inoperative by the selective actuation of switches on panel 7 (Fig. 1).

The motors *20a* and *20b* can be reversible for backward driving, in which case a second sensing means 21′ is provided on the rear underside of the carriage. An arrangement of this type is shown in Fig. 3 wherein, furthermore, the traction wheels *6a*, *6b* are arranged in the centre of the carriage whilst the swivelable idler wheels *5a* and *5b* of Figs. 1 and 2 are replaced by two longitudinally spaced swivelable wheels *5c* and *5d* in each half of the carriage. Wheels *6a* and *6b* are driven, as illustrated in Fig. 4, from a single reversible motor 20 via a speed reducer 25 and a pair of electra-magnetic transmission devices *26a*, *26b* as well as pairs of chain drives *126a*, *126b*. The transmission devices *26a* and *26b* are independently energizable, as described hereinafter with reference to Fig. 7, to complete the power transmission path from motor 20 to traction wheels *6a* and/or *6b*. These transmission devices may include magnetic clutches as well as magnetic brakes, actuation of one clutch and of the opposite brake affording a more positive steering action.

As shown in Fig. 3 the carriage can have in addition to the front sensing means 21 also a rear sensing means 21′ whereby only the sensing means at the front in the direction of travel is connected in. The switching over of the sensing means can take place manually or automatically by a pulse transmitted externally and received by the carriage. Simultaneously with the switching over of the sensing means the motor 20 can be switched over and the rapid stopping de-

vice with the appropriate sensing element in the direction of travel can be connected in.

In Fig. 3 the axis of traction wheels 6*a*, 6*b* is at a distance from the sensing means. The reading devices 30-35 are the same as in Fig. 2 but may be supplemented by other reading switches for rearward travel; one such reading element in the form of a magnetic switch, whose specific function will be described hereinafter, is shown at 35′.

Fig. 5 shows a portion of the guide strip 17 along with two branch strips 17*a* and 17*b* leading to the left and to the right, respectively. At the first V-junction 29*a*, a set of code markers 130*a*, 131*a* and 133*a* in the form of permanent magnets, substantially level with the floor surface and the strip 17, enable an oncoming vehicle to continue on a straight path along strip 17 or to veer to the left along strip 17*a*, depending on the setting of the selector switch on panel 7 (Fig. 1). At the second V-junction 29*b*, a similar array of code markers 130*b*, 132*b* and 134*b* enable an analogous selection between a straight-ahead continuation along strip 17 and a turning to the right along strip 17*b*. With reading elements 32 and 33 deactivated as described hereinbefore with reference to Fig. 2, the vehicle will move straight at junction 29*a* (arrow A) and to the right at the junction 29*b* (arrow B).

It will be noted that the central marker 130*a* or 130*b* coincides with the strip 17. This is entirely feasible when the strips consist of nonmagnetic conductive material designed for capacitive sensing as described hereinafter with reference to Fig. 8. In the case of a ferromagnetic strip, designed for inductive pick-up as later described with reference to Fig. 9, all the markers would have to be well spaced from the strip.

As the sensing of the guide strip and the reading of the markers takes place without contact, the sensors and reading elements on the one hand, and the guide strip and magnetic markers, on the other hand, may be covered with a thin protective layer of varnish or the like.

The operation of the carriage of Fig. 2 is explained in detail by means of the circuit diagram of Fig. 6 and the path shown in Fig. 5 by arrows A and B. The parts of the carriage in the circuit diagram of Fig. 6 are represented relative to the guide strip 17 when looking down on the carriage.

The two motors 20*a*, 20*b* are energizable by a source of direct current aboard the carriage, illustrated as a battery 40. A single circuit breaker 12 in series with the ungrounded negative terminal of that source represents the two series-connected switches 12*a*, 12*b* of the sensing element 11 of the rapid stopping device of Fig. 1. Upon closure of this circuit breaker, a bus bar 41 carries negative operating voltage to four signal generators 122*a*, 122*b*, 123, 124 of sensing means 21, whereby a signal generator is associated with each of the sensors 22*a*, 22*b*, 23*a* and 24*a* of sensing heads 22, 23, 24. The nature of these signal generators and the mode of their operation by the sensors will be described later in connection with Figs. 8 and 9. For the present purpose, and as illustrated diagrammatically in Fig. 6, each signal generator is assumed to comprise a normally open switch which closes whenever the corresponding sensor is aligned with the strip 17.

The control means has four relays 222*a*, 222*b*, 223 and 224, energizable from bus bar 41 via the respective signal generators 122*a*, 122*b*, 123, 124. These relays control the operation of two driving relays 120*a*, 120*b* to energize the two drive motors 20*a*, 20*b* respectively. If both relays 223 and 224 are concurrently operated, an energizing circuit is completed for both driving relays 120*a* and 120*b* via the upper armatures and front contacts of these sensing relays, upper armature and back contact of test relay 223 in the case of driving relay 120*a*, and lower armature and back contact of test relay 224 in the case of driving relay 120*b*. The upper armature and back contact of relay 223 are normally shunted by the other right-hand armature and back contact of a control relay 220*a*; similarly, the lower armature and back contact of relay 224 are normally shunted by the outer left-hand armature and back contact of a control relay 220*b*. The working contacts of the armatures of relays 120*a* and 120*b* are connected to bus bar 41 via a potentiometer 42 whose slider may be adjusted for equalizing the torque exerted by the two driving motors 20*a*, 20*b* upon the respective traction wheels 6*a*, 6*b* (Fig. 2) so as to ensure travel on a straight course.

Control relays 220*a* and 220*b* are energizable upon the concurrent closure of magnetic switches 30, 34 and 30, 33, respectively. Closure of any of magnetic switches 31, 32, 35 simultaneously with switch 30 operates a further control relay 220*c* whose armatures and back contacts are connected in respective holding circuits for relays 220*a* and 220*b*. The first of these holding circuits extends from the winding of relay 220*a* via its outer left-hand armature and rest contact, lower rest contact and armature of relay 220*c*, and inner left-hand armature and rest contact of relay 220*b* to bus bar 41; the second holding circuit extends to this bus bar 41; the second holding circuit extends to this bus bar from the winding of relay 220*b* by way of its outer right-hand armature and working contact, upper armature and rest contact of relay 220*c*, and inner right-hand armature and rest contact of relay 220*a*. Thus, each of relays 220*a* and

220*b* can lock only when neither the opposite control relay 220*b*, 220*a* nor the "straightahead" relay 220*c* is operated.

The width of the guide strip 17 should be so chosen that, whenever the vehicle veers sufficiently off course to either side to disalign either or both central sensors 22*a*, 22*b* of central sensing head 22 with that strip, one of the lateral sensors 23*a*, 24*a* of the lateral sensing heads 23, 24 finds itself in registry with the strip to generate a corrective signal. This will always be the case if the strip width is substantially equal to the length of a side of the square, preferably a diamond defined by the sensors 22*a*, 22*b*, 23*a*, 24*a*. Since, however, the vehicle is not expected to swerve sharply from its original path, it will generally suffice to make this width equal to about half the transverse diagonal 23*a*-24*a* of this sensing arrangement. As the length of the longitudinal diagonal 22*a*-22*b* relative to the width of the strip, determines the maximum yawing angle before corrective action occurs, the latter diagonal advantageously is made somewhat longer than the transverse diagonal. Reducing the strip width, furthermore, increases the precision with which the reading element switches 30-35 will line up with the corresponding markers so that the width of the latter may also be reduced.

If, with relays 220*a*, 220*b* 220*c* deenergised, the vehicle deviates from its guide path sufficiently to let one of the central sensors (generally the leading sensor 22*a*) move off the strip 17, the corresponding relay (e.g. 222*a*) will be released so that the circuit of relays 120*a* and 120*b* is broken. With these relays de-energized, the armature windings of motors 20*a* and 20*b* are open-circulated at the inner left-hand armature of relay 220*a* and the inner right-hand armature of relay 220*b*, respectively. One of the driving relays, however, is held operated by the substantially concurrent response of one of the lateral sensors, such as sensor 23*a* if the deviation has been to the left. With signal generator 123 operating the relay 223, an alternative energizing is closed for driving relay 120*b* from bus bar 41 via the lower armature and working contact of relay 223. Thus, motor 20*b* remains under power to drive the associated traction wheel 6*b* while the opposite traction wheel 6*a* idles; this results in a gradual course correction with the vehicle veering slightly to the right until both central sensors 22*a* and 22*b* are again aligned with the strip 17 to restore rectilinear motion.

As the vehicle, traveling on a straight line, passes the junction 29*a* of Fig. 5 in the direction of arrow A, sensors 22*a*, 22*b* and 24*a* will concurrently respond to the proximity of strips 17 and 17*a*. The rsponse of sensor 24*a* excites the relay 224 whose upper armature and working contact close an energizing circuit for driving relay 120*a*. Since this relay, along with counter-relay 120*b*, is already operated via relays 222*a* and 222*b*, the presence of branch strip 17*a* underneath the carriage is without effect. With reading elements switch 31 activated and reading element switch 33 deactivated, relay 220*c* is momentarily energized by the simultaneous closure of switches 30 and 31 upon the approach to junction 29*a* to release control relay 220*a* or 220*b* if either of them had been previously actuated. On a differently programmed carriage, having reading element switch 33 operative and reading element switch 31 inoperative, relay 220*b* would have been energized via simultaneously closed switches 30 and 33 on the approach of junction 29*a*. This relay, which locks over its outer right-hand armature and working contact, would have opened, at its parallel circuit on the outer left-hand armature and rest contact, the relay 223 whereby the latter relay, on being operated by the response of sensor 24*a* to branched strip 17*a*, would have broken the energizing circuit of relay 120*b* notwithstanding the continued operation of relays 222*a* and 222*b*. The armature winding of motor 20*b* would then have been short-circuited by the earthing of its left-hand terminal via the armature and rest contact of relay 120*b* and the inner right-hand armature and working contact of relay 220*b*. This would have resulted in the exertion of a braking force upon the left-hand traction wheel 6*b*, with motor 20*a* continuing to drive the right-hand wheel 6*a*; the vehicle would then have turned onto the branch path 17*b*, its leftward swing being interrupted only momentarily during passage of sensor 23*a* across the strip 17 with brief reoperation of relay 120*b* and motor 20*b*.

As the vehicle with the original switching state (reading element switches 31, 34, 35 as shown in Figs. 2 and 3) approaches the junction 29*b* along strip 17, reading element switch 34 passes over marker 134*b* concurrently with the passage of reading element switch 30 over marker 130*b* so that control relay 220*a* is actuated. In a manner analogous to that described above with reference to relay 220*b*, relay 220*a* causes the deenergization of driving relay 120*a* as soon as sensor 23*a* picks up the branch strip 17*b* whereby motor 20*a* is braked by the short-circuiting of its armature winding via the armature and rest contact of relay 120*a* in series with the inner left-hand armature and working contact of relay 220*a*. With relay 120*b* remaining operated under the control of sensor 23*a*, the left-hand traction wheels 6*b* is powered while the right-hand wheel 6*a* is braked. The resulting rightward swing, which turns the vehicle onto the

branch path defined by strip 17*b*, is again momentarily interrupted by a brief re-energization of relay 120*a* as the sensor 24*a* detects the forward extension of strip 17; thereafter, if (as is likely) the vehicle has not yet fully aligned itself with the strip 17*b* so that the front sensor 22*a* is not above that strip, sensor 23*a* again takes over the exclusive control of the driving circuit so that motor 20*b*, alone, remains operated.

With relay 220*a* locked operated, the steering of the vehicle along strip 17*b* would proceed in essentially the same fashion as heretofore described with reference to strip 17, except for a sharper corrective action (owing to the braking of motor 20*a*) whenever it strays off course, to the left of its guide path; a similar situation exists along strip 17*a*, with regard to rightward deviation, for a vehicle whose relay 220*b* is energized. To restore the more gradual and symmetrical mode of guidance explained above, therefore beyond each junction a combination of markers 130′, 135′ and 130″, 135″ are provided to actuate the relay 220*c* by simultaneous closure of reading element switches 30 and 35 to release the relays 220*b* and 220*a*, respectively. If the speed of the carriage in passing over these junctions is low enough, the braking circuits leading over the front contacts of relays 120*a* and 120*b* could be omitted, thus eliminating the need for these additional markers on branch paths 17*a*, 17*b*. Conversely, the rest contacts of relays 120*a* and 120*b* could be permanently earthed if the nondriven drive wheel is to be braked under all circumstances.

When ever the carriage reaches the end of its guide path so that at least the sensors 22*a*, 23*a* and 24*a* are no longer above a guide strip, both motors 20*a*, 20*b* are deactivated so that the vehicle comes to a halt. Naturally such stoppage also occurs, if the vehicle is thrown off its course, e.g. on impact with an obstacle.

If the carriage is conditioned for rearward travel, as by operation of a reversing key on the panel 7 of Fig. 1, another set of relays similar to those shown in Fig. 6 take over the control of motors 20*a*, 20*b*. Reading element switch 35′ may then control the counterpart of relay 220*c*, in a manner analogous to that of reading element switch 35, upon encountering a marker on its side of the guide strip.

It will be noted that, according to Fig. 5, code markings at junctions 29*a* and 29*b* differ from each other by the relative position and spacing of the bar magnets serving as markers. If the number of junctions to be successively traversed by one carriage is small, the control commands to be performed at these junctions can be generated by different groupings of selectively actuable reading element switches. In a more complex system a single group of reading element combinations may be selectively activated, at successive junctions, by a programmer aboard the carriage which could be stepped, for example, by each actuation of reading element switch 30 or by the operation of relay 220*c* upon passage over any branching point.

Fig. 7 shows part of the circuit diagram of Fig. 6, including the control relays 220*a* and 220*b*, modified to serve for the control of a carriage as illustrated in Figs. 3 and 4. This carriage has a single drive motor 20 for both drive devices of traction wheels 6*a*, 6*b*. It is connected directly between earth and bus bar 41 which is again energized from the negative terminal of battery 40 via switch 12 of the rapid stopping device. As in the preceding embodiment, the switches for the possible reversal of the motor and connecting it to an alternate control circuit have not been illustrated.

In Fig. 7 the driving relays 120*a*, 120*b* have been each provided with a second armature to control both the clutch portions 27*a*, 27*b* and the brake portions 28*a*, 28*b* of the associated electromagnetic transmission devices 26*a*, 26*b* (cf. Fig. 4). When energized, relay 120*a* or 120*b* operates the clutch 27*a* or 27*b* to power the corresponding traction wheel 6*a* or 6*b*. In its unoperated state, relay 120*a* connects via its right-hand armature and rest contact the brake 28*a* to the inner left-hand armature of relay 220*a* whose working contact is linked to bus bar 41; thus, brake 28*a* becomes effective only with relay 120*a* released and relay 220*a* energized. In like manner, unoperated relay 120*b* connects via its left-hand armature and rest contact the brake 28*b* to the inner right-hand armature of relay 220*b* whose working contact is linked to bus bar 41 whereby the brake 28*b* is actuated only when the unoperated state of relay 120*b* coincides with the energized condition of relay 220*b*. Thus, the operation of this system is analogous to that of the system of Fig. 6 inasmuch as either traction wheel, when nondriven, idles on straightforward steering but is braked when the corresponding control 220*a* or 220*b* has been set for turning to one side or the other.

Once again, the rest contacts of relays 120*a* and 120*b* could be permanently connected to bus bar 41 if a nondriven drive wheel is to be invariably braked.

Fig. 8 shows details of a sensing head 23*a*. The remaining sensing heads in Fig. 6 are identical. The sensing head 23*a* has a sensor 23*a*A and is connected to a relay 223A of the control means. Sensor 23A is a conductive plate located a short distance above an earthed conductive guide strip 17A to form therewith a capacitor connected in parallel with an inductance 43A as part

of a resonant circuit in the feedback path of a high-frequency oscillator 44A. Upon disalignment of plate 23A with conductive strip 17A, the parallel capacitance is greatly reduced as the sensor faces only the non-conductive floor beneath it; this results in a sharp detuning or a complete deactivation of the oscillator 44A. When, however, the sensor plate 23A registers with strip 17A, oscillator 44A has an operating frequency in the pass bank of a bank-pass filter 45A whose output, after rectification at a diode network 46A, energizes the corresponding sensing relay here designated 223A.

Fig. 9 shows a broadly similar sensing head 23B whose sensor 23*a*B is a length of horizontal wire closely spaced from a highly permeable guide strip 17B so as to introduce a supplemental inductance into a resonant circuit of a high-frequency oscillator 44B, this resonant circuit including a coil 43B and a capacitor 47B in series with the wire. As before, the absence of the guide strip detunes the oscillator 44B which otherwise operates at a frequency passed by a bank filter 45B to actuate a sensing relay 223B after rectification at 46B.

The arrangements illustrated in Figs. 8 and 9 are representative of a variety of ways in which a sensor may capacitively or inductively detect the proximity of an electrically conductive and/or ferromagnetic guide strip by modifying the reactance of a circuit controlling the operating frequency of an oscillator. However, the guide strip can also be sensed according to other methods e.g. photo-electric receivers for a reflected light beam. However, this is more complicated and more liable to faults due to the danger of contamination. Similar capacitive, inductive or optical circuit elements may also be used as reading elements, in lieu of the magnetic switches 30-35 for the code markings along the path and in particular at the V-junctions. Thus, as when sensing the guide strip proximity switches can be used. Naturally, the electro-magnetic relays shown in Figs. 6-9 could be replaced by equivalent electronic circuitry.

A number of other advantageous embodiments are possible. It is particularly advantageous if the carriage has an arrangement of traction wheels 6*a*, 6*b* and freely swivelable wheels 5*c*, 5*d* according to Fig. 3 and a sensing means 21 as well as drive devices for the traction wheels according to the embodiment of Fig. 2. The traction wheels are then in the centre of the vehicle and the sensing means is positioned between the drive wheels and symmetrically to a vertical plane passing through the axis of the traction wheels. This construction provides a particularly effective steering of the carriage, whereby the same sensing means can be used for the guide strip without any reversals both for forward and rearward travel of the carriage. This carriage is particularly manoeuverable and permits travel over route paths wherein the guide strip turns at particularly sharp angles. Depending on the arrangement of the code markings along the route path and the reading means on the carriage, the latter can be located in the area of the traction wheels. If necessary however the reading means may have to be arranged at a distance from the sensing means.

The sensing means, unlike in the embodiments shown, can be equipped with a central sensing head having only one sensor, as is the case with the outer sensing heads. The sensors are then appropriately located in a row at right angles to the direction of travel. The lateral spacing between sensors is then preferably relatively small.

The steering of the carriage then takes place by changing the rotation speeds of the traction wheels. This can be carried out as described hereinbefore. It is also possible in order to obtain the relative speed difference to permit one wheel to be driven in an unchanged manner but to increase the driving speed of the other traction wheel. Furthermore, such an arrangement makes both active and passive steering possible. In passive steering only that traction wheel is braked or stopped about which the carriage is to be swivelled. In active steering on deviation of the carriage from the guide strip the drive devices of the carriage are firstly stopped and only the drive of the wheel on the outside of the turn is engaged. Modifying the carriage according to Figs. 3, 4 and 7 it can be appropriate to connect the electromotor 20 via a differential gear with the transmission devices of the drive devices of the left and right tranction wheel. In this case it is not necessary for the transmission devices to have clutches. It is sufficient if each drive device has a brake which can be operated by the sensing means via the control means. It is further particularly preferred if the drive motors are permanently energised and can be braked by short-circuiting. Self-locking gears are also suitable as brakes for the drive devices of the traction wheels.

In place of the reading means of the carriage as described and represented in the exemplified embodiments it is particularly advantageous to provide the transportation system with a destination indication, as for example described in Patent Specification No. 1 190 211. Each V-junction has then a specific code marking designating the junction number and the reading means of the carriage has at least one group of reading elements responding to the marking points of the code markings corresponding to the possible junction code markings. The

junction code markings are preferably based on the decimal system. On the carriage can be connected in a ready-to-receive state the reading element of the reading means corresponding to a destination code. With a total or partial agreement of the code markings of the V-junctions with those of the reading means an active steering pulse is supplied to the carriage control means. As a result of the destination code set on the reading means of the carriage and the code markings of the junction, the route to be taken by the carriage at every junction is determined unequivocally and uniformly at any point in the transportation system.

The carriage control means can also be equipped with a floor coding device having a number of generator elements corresponding to the number of marking points of the possible floor destination code, whereof the generator element corresponding to a particular floor destination code can always be connected in. The floor destination code acts on a reading device of a lift system and thereby controls the lift which is included in the transportation system and in which the carriage can travel. The final destination code can therefore comprise a branching point destination code and a floor destination code.

Further possibilities exist regarding the control of the carriage at the V-junctions. Thus, the guide strip of both the straight ahead path and the branching path can be interrupted at the junction. When the code set on the reading means partly or totally agrees with the code marking of the junction, the carriage can receive a positive steering pulse and diverge outwards. It then travels a certain distance without a guide strip, e.g. not be driven, until it again makes contact with the guide strip. If the code marking gives no control pulse to the carriage then the latter passes over the junction, e.g. also possibly not driven, until it is in contact with the guide strip.

Advantageous control of the carriage at the V-junctions is also brought about if only one of the guide strips branching off at the junction is interrupted, i.e. starts at a spacing from the junction. Two possibilities then exist, in the first the straight ahead guide strip is continuous and the branching off guide strip is interrupted. In the case of the total or partial agreement of the code marking of the V-junction with the destination code yet this leads to a temporary disconnection of the sensing means and to a positive diverging movement of the carriage. However, the other possibility is preferable, whereby the straight ahead guide strip is interrupted, in which case the carriage control can take place in such a way that with a partial or total agreement of the code marking of the V-junction with the carriage destination code the sensing means for the guide strip is simply cut out, whereby the carriage can no longer follow the branching guide strip and instead travels straight ahead. It is then no longer necessary to give the carriage a positive steering pulse.

WHAT WE CLAIM IS:—

1. A carriage including two laterally spaced traction wheels and track sensing means adapted to sense a track without contracting the same, for use in an automatic transportation system including a track sensable by said sensing means, said sensing means comprising a central sensing device situated substantially on the longitudinal centre-line of the carriage, and two lateral sensing devices situated one on each side of said centre-line, said central sensing device being operative, upon sensing said track in use, to cause the said traction wheels to rotate at the same speed and each of the said lateral sensing devices being operative, upon sensing the track in use, to cause the said traction wheels to rotate at mutually different speeds, in such manner as to steer the carriage along the track.

2. A carriage as claimed in claim 1, wherein the said sensing means is situated between the centre of the length of the carriage and one end thereof, for steering the carriage along said track with said one end leading.

3. A carriage as claimed in claim 2, including a second sensing means similar to the first-mentioned sensing means, said second sensing means being situated between the centre of the length of the carriage and the other end thereof, for steering the carriage along said track with said other end leading, only one of said sensing means being operative at any time.

4. A carriage as claimed in claim 1, wherein the said traction wheels are substantially coaxial and are situated substantially at the centre of the length of the carriage, and the said sensing means is situated in the region between the said wheels, for steering the carriage along said track with either end of the carriage leading.

5. A carriage as claimed in any of the preceding claims, wherein the said sensing devices of the or each sensing means are arranged in a row substantially at right angles to the longitudinal centre-line of the carriage.

6. A carriage as claimed in any of claims 1 to 4, wherein in the or each sensing means the lateral sensing devices each comprise only one sensor which sensors are arranged on an imaginary line perpendicular to the longitudinal centre-line of the carriage and are spaced equal distances from said centre-line, whilst the said central sensing device comprises two sensors which are spaced from one another along the said centre-line

and are spaced equal distances from said imaginary line.

7. A carriage for use in an automatic transportation system, substantially as hereinbefore described with reference to Figures 1, 2, 6 and 8 of the accompanying drawings.

8. A carriage as claimed in claim 7 but modified substantially as hereinbefore described with reference to Figure 9 of the accompanying drawings.

9. A carriage as claimed in claim 7 but modified substantially as hereinbefore described with reference to Figures 3, 4 and 7 of the accompanying drawings.

10. An automatic transportation system comprising at least one carriage as claimed in any of claims 1 to 9, and a track sensable by the sensing means of the or each said carriage.

11. A system as claimed in claim 10, wherein the said lateral sensing devices of the or each sensing means of the or each carriage are spaced apart by a distance which is substantially twice the width of the said track.

12. A system as claimed in claim 10 or 11, wherein the or each said sensing device of the or each said carriage includes at least one oscillator connected in a circuit which, in operation, includes the said track and the impedance of which circuit is such that, when the oscillator faces the track, oscillations take place in said circuit.

13. A system as claimed in claim 12, wherein the or each said circuit has a filter at its output arranged to cause a control signal to be generated when oscillations take place in the circuit.

14. A system as claimed in any of claims 10 to 13, which includes a track portion substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

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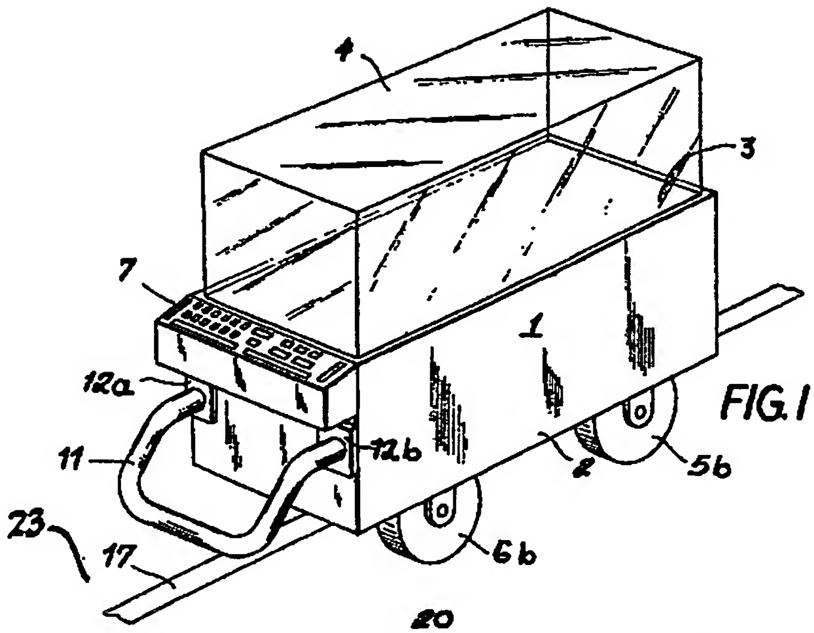


FIG. 1

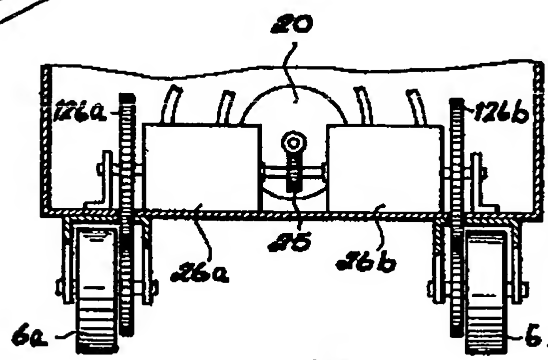


FIG. 4

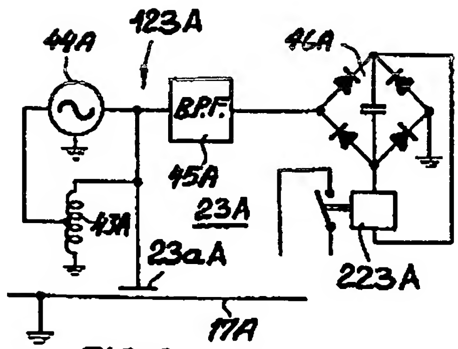


FIG. 8

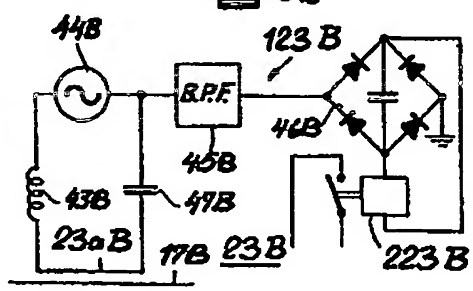


FIG. 9

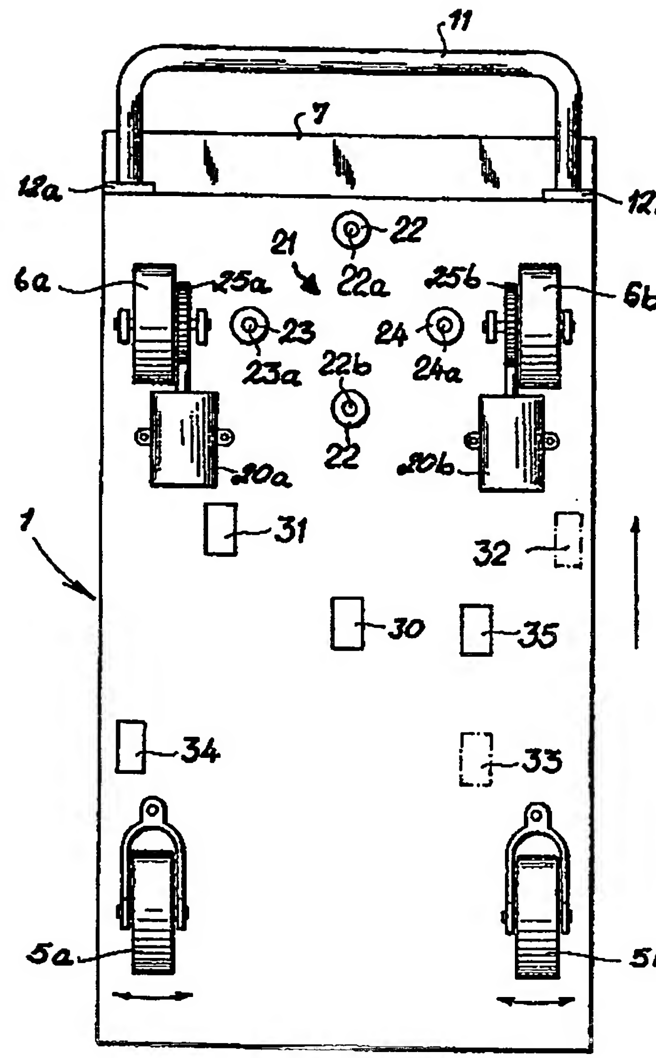

11
7
12a
12b
22
21
22a
25a
25b
6a
6b
23
24
23a
22b
24a
22
20a
20b
1
31
32
30
35
34
33
5a
5b

FIG. 2

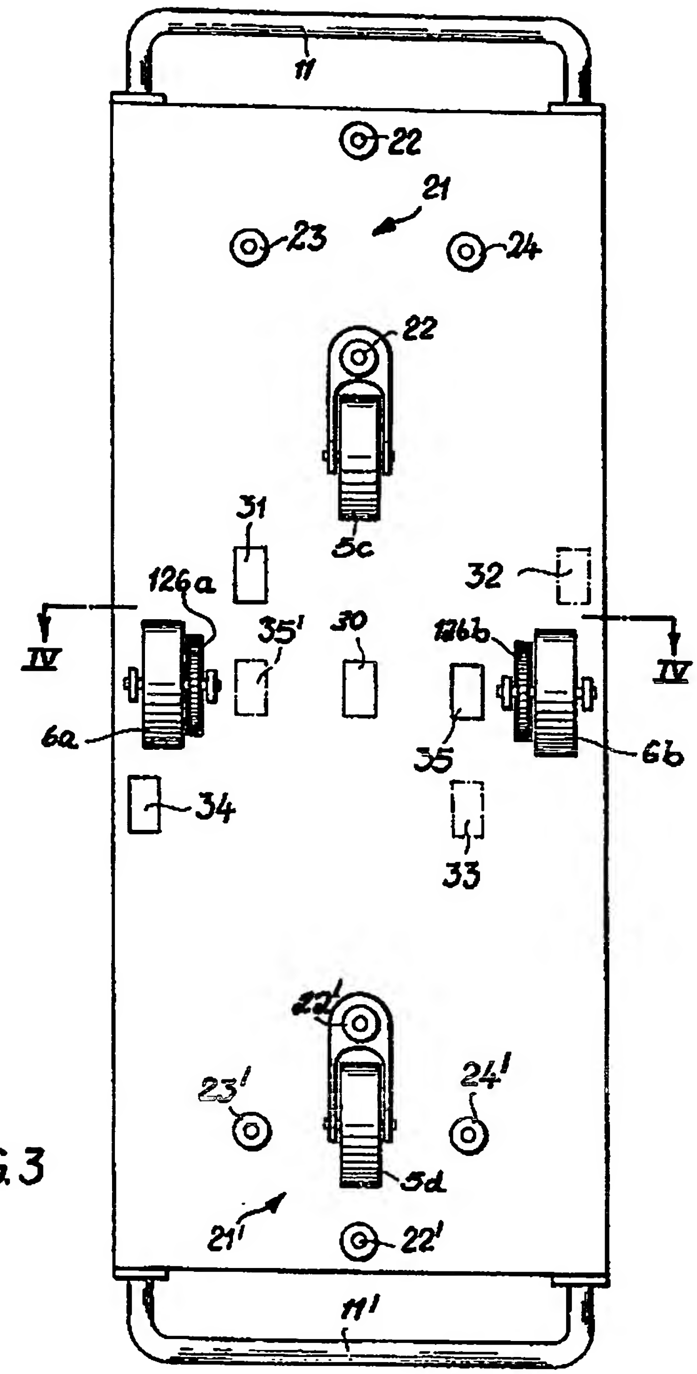

11
22
21
23
24
22
31
5c
32
126a
35'
30
126b
IV
IV
6a
35
6b
34
33
22'
23'
24'
5d
21'
22'
11'

FIG. 3

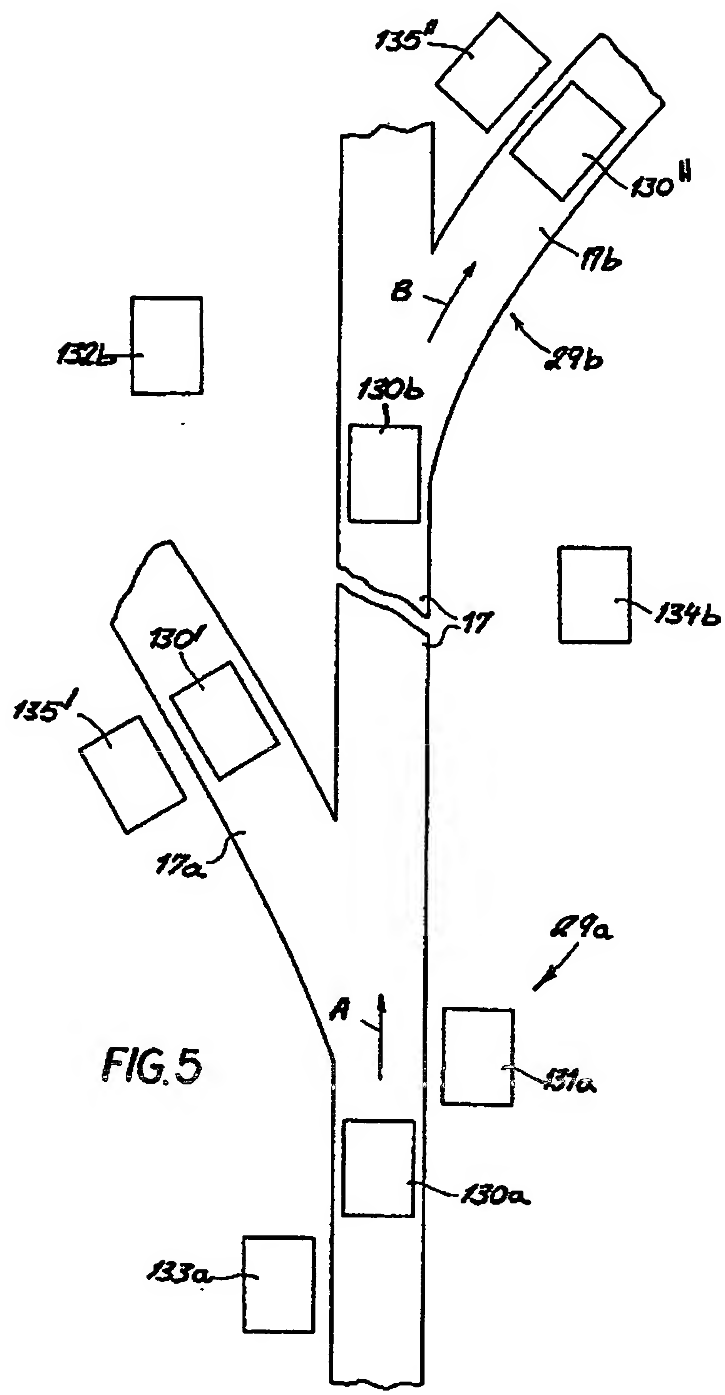
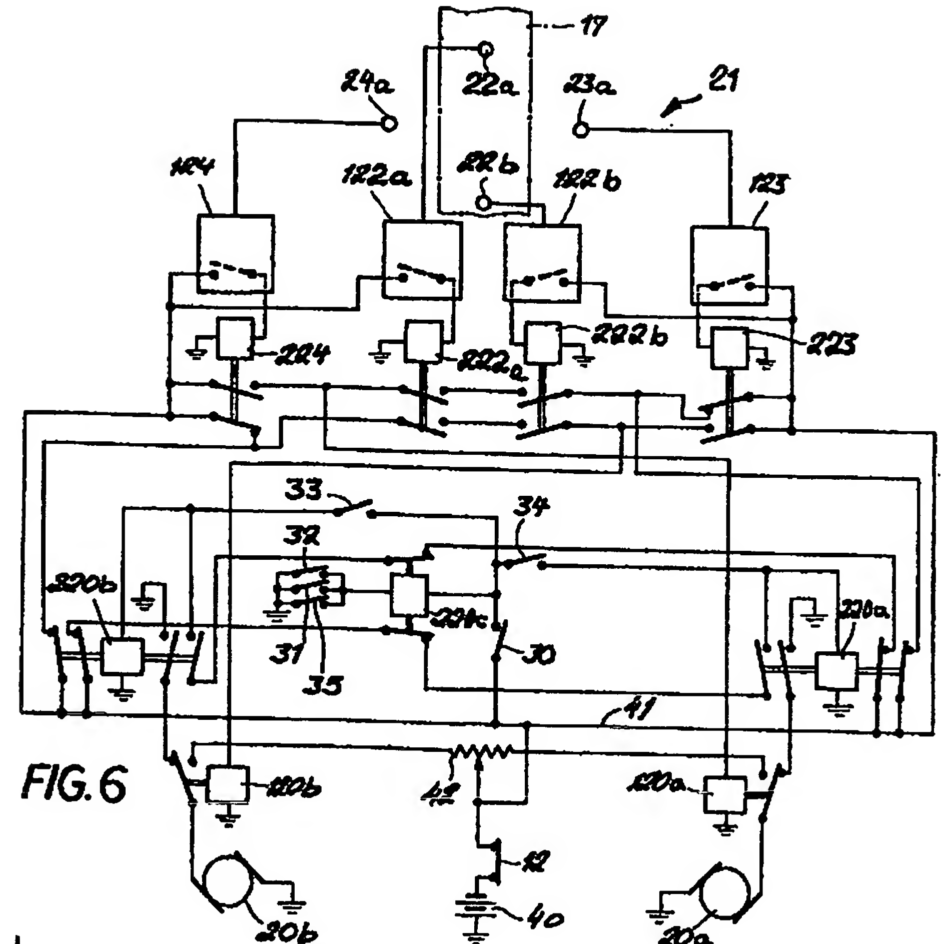

135''
130''
17b
B
29b
132b
130b
134b
17
130'
135'
17a
29a
A
131a
130a
133a

FIG. 5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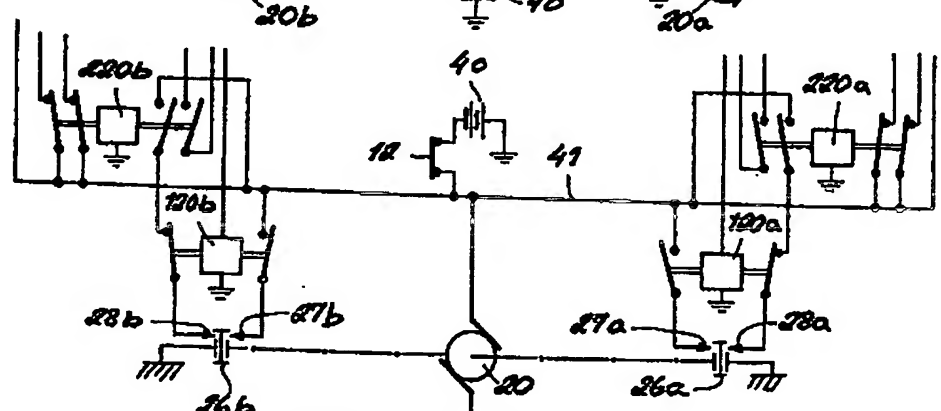
24a
23a
21
124
122a
22b
122b
123
224
222a
222b
223
33
34
32
220b
221
220a
31
35
30
41
42
120b
120a
12
40
20b
20a

FIG. 6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40
220a
12
41
120b
120a
28b
27b
27a
28a
26b
20
26a

FIG. 7